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| 10/679,783      | 10/06/2003  | Rajneesh Jaiswal     | TI-34403.1          | 3720             |

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| EXAMINER |
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MCDONALD, RODNEY GLENN

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| ART UNIT | PAPER NUMBER |
|----------|--------------|

1753

DATE MAILED: 05/02/2005

Please find below and/or attached an Office communication concerning this application or proceeding.

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|------------------------------|---------------------------------------|--------------------------------------|--|
| <b>Office Action Summary</b> | <b>Application No.</b><br>10/679,783  | <b>Applicant(s)</b><br>JAISWAL ET AL |  |
|                              | <b>Examiner</b><br>Rodney G. McDonald | <b>Art Unit</b><br>1753              |  |

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

### Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

### Status

- 1) ☒ Responsive to communication(s) filed on 25 April 2005.
- 2a) ☐ This action is **FINAL**.                      2b) ☒ This action is non-final.
- 3) ☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

### Disposition of Claims

- 4) ☒ Claim(s) 13, 14 and 16-18 is/are pending in the application.
- 4a) Of the above claim(s) \_\_\_\_\_ is/are withdrawn from consideration.
- 5) ☐ Claim(s) \_\_\_\_\_ is/are allowed.
- 6) ☒ Claim(s) 13, 14 and 16-18 is/are rejected.
- 7) ☐ Claim(s) \_\_\_\_\_ is/are objected to.
- 8) ☐ Claim(s) \_\_\_\_\_ are subject to restriction and/or election requirement.

### Application Papers

- 9) ☐ The specification is objected to by the Examiner.
- 10) ☐ The drawing(s) filed on \_\_\_\_\_ is/are: a) ☐ accepted or b) ☐ objected to by the Examiner.  
Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).  
Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).
- 11) ☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

### Priority under 35 U.S.C. § 119

- 12) ☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).
- a) ☐ All    b) ☐ Some \*    c) ☐ None of:
1. ☐ Certified copies of the priority documents have been received.
  2. ☐ Certified copies of the priority documents have been received in Application No. \_\_\_\_\_.
  3. ☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).
- \* See the attached detailed Office action for a list of the certified copies not received.

### Attachment(s)

- |  |   |
|--|---|
| 1) <input checked="" type="checkbox"/> Notice of References Cited (PTO-892)  | 4) <input type="checkbox"/> Interview Summary (PTO-413)<br>Paper No(s)/Mail Date. _____ |
| 2) <input type="checkbox"/> Notice of Draftsperson's Patent Drawing Review (PTO-948)                                   | 5) <input type="checkbox"/> Notice of Informal Patent Application (PTO-152)             |
| 3) <input type="checkbox"/> Information Disclosure Statement(s) (PTO-1449 or PTO/SB/08)<br>Paper No(s)/Mail Date _____ | 6) <input type="checkbox"/> Other: _____  |

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## **DETAILED ACTION**

### ***Continued Examination Under 37 CFR 1.114***

A request for continued examination under 37 CFR 1.114, including the fee set forth in 37 CFR 1.17(e), was filed in this application after final rejection. Since this application is eligible for continued examination under 37 CFR 1.114, and the fee set forth in 37 CFR 1.17(e) has been timely paid, the finality of the previous Office action has been withdrawn pursuant to 37 CFR 1.114. Applicant's submission filed on April 25, 2005 has been entered.

### ***Claim Rejections - 35 USC § 103***

The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

(a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negated by the manner in which the invention was made.

This application currently names joint inventors. In considering patentability of the claims under 35 U.S.C. 103(a), the examiner presumes that the subject matter of the various claims was commonly owned at the time any inventions covered therein were made absent any evidence to the contrary. Applicant is advised of the obligation under 37 CFR 1.56 to point out the inventor and invention dates of each claim that was not commonly owned at the time a later invention was made in order for the examiner to consider the applicability of 35 U.S.C. 103(c) and potential 35 U.S.C. 102(e), (f) or (g) prior art under 35 U.S.C. 103(a).

1. Claims 13 and 14 are rejected under 35 U.S.C. 103(a) as being unpatentable over Licata (U.S. Pat. 6,132,564) in view of Lane et al. (GB 2 240 875).

Licata teach that the manufacture of semiconductor devices and integrated circuits involves the blanket and selective deposition and removal of many layers of conductive, insulating, and semiconductive materials on substrates that are usually in the form of silicon wafers. The manufacturing processes typically include the formation of a series of metal interconnect film stacks on a wafer by a plurality of sequential processes performed in a series of processing chambers of one or more multi-process vacuum processing tools. (Column 1 lines 12-19)

***According to the invention cleaning is carried out by a soft sputter etch with ions of an inert gas such as argon before depositing.*** (Column 2 lines 59-60)

FIG. 3, for example, diagrammatically illustrates ***a semiconductor wafer processing cluster tool 100*** for carrying out certain of the embodiments of the methods described above. The tool 100 preferably includes ***a vacuum transfer module 103 (Compare to Applicant's requirement for maintaining vacuum between the reactors)*** to which are attached one or two loadlock modules 101,102 which are connected to two positions of the transfer module 103 ***having a conventional robot transfer arm 104 (Compare to Applicant's requirement for a means for advancing the wafer)*** therein. The transfer module 103 is illustrated as having three additional positions to which are attached ***processing modules 105, 106 and 107***, none of which need be a dedicated precleaning module. While only three such additional positions are

illustrated, more may be provided or to one may be connected a further transfer module for transfer of substrates to other processing modules attached thereto.

In accordance with one preferred embodiment of the invention, ***the module 104 is a combined plasma pre-clean and plasma-based deposition module preferably of the type illustrated and described in connection with FIG. 2 below. The module 105 is controlled to operate, in the programmed sequence of the tool 100, as a plasma precleaning and first metal layer deposition module. (Compare to Applicant's first reactor for performing sputter etch) The additional modules 106 and 107 are, for example, both deposition modules. The module 106 may, for example, be a CVD module for the deposition of a second film, such as tungsten or another material that is common in semiconductor device manufacture. The Next chamber 108 may be equipped for the PVD of another material. (Compare to Applicant's requirement for providing a second reactor for depositing a layer of a metal and means for depositing a layer of metal.)*** This additional chamber 108 may be a chamber that could not otherwise be attached to the transfer module 103 because its position would normally be occupied by a dedicated precleaning module, which has been eliminated by the present invention.

Fig. 2 diagrammatically illustrates ***a precleaning module 10.*** (See Fig. 2; Column 5 lines 62-63) ***(Compare to Applicant's first reactor for performing sputter etch)***

The module 10 includes a vacuum tight processing space 11 enclosed in a chamber 12. Mounted in the chamber 12 at one end thereof is a wafer support or

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susceptor 14 for supporting a semiconductor wafer 15 mounted thereon. The wafer 15, when mounted on the support 14, is parallel to and faces a target 16. The target 16 is formed of a sputter coating material, for example, titanium metal. The processing space 11 is a generally cylindrical space that it maintained at an ultra high vacuum pressure level and is filled with a processing gas, such as argon, during processing, and may include some other gas such as nitrogen. The space 11 lies in the chamber 12 between the support 14 and the target 16. (Column 6 lines 1-11)

***The coil 30 inductively couples energy into process gas in the volume 26, forming an inductively coupled plasma (ICP) that generally fills the space 26. An RF generator 32, preferably operative in the range of from 0.2 to 60 MHz, for example of a frequency of 2 MHz, is connected to the coil 30 through a matching network 33 to provide the energy to the coil 30 to form the plasma in the volume 26. (Column 7 lines 26-33) (Compare to Applicant's requirement for providing means for producing an inductively coupled plasma adjacent to the surface of the wafer)***

***Sources of processing gas 40, such as argon and nitrogen, are connected to the chamber 11, through a flow control device 41. (Column 7 lines 33-35) (Compare to Applicant's requirement for means for passing argon to the chamber)***

In accordance with one preferred embodiment of the invention, the module 10 is operated ***to perform a plasma precleaning of the wafer 15***. In operation argon gas is maintained in the chamber 12 at approximately 10 millitorr and ICP power from the generator 32 is increased to 3.5 kWatts, while ***the substrate bias applied by the***

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**generator 27 to the substrate 15 is increased to a negative of 50 to 100 volts. A** low power of approximately 500 to 1500 watts is applied by the power supply 20 to the target 16. (Column 9 lines 35-46) **(Compare to Applicant's requirement for providing an RF signal to the wafer)**

**The RF generator 27 operates from 0.2 to 80 MHz.** (Column 9 lines 13-15) **(Compare to Applicant's requirement for providing an RF signal to the wafer)**

As a result of such operation of the module 20, titanium is sputtered from the target 16 and is ionized in the ICP in space 26 along with atoms of the argon gas. The ions of titanium and argon are accelerated onto the substrate 15 by the bias voltage applied to the substrate. The heavier titanium ions that are included with the ions that bombard the substrate 15 **effectively enhance the cleaning of native oxides and water vapor from the substrate surface and also react with the contaminants to reduce oxides on the surface and to dissolve oxygen into the titanium film.** The parameters of target power, ICP power and substrate bias are maintained at a balance such that material is removed from the surface or diluted before the surface becomes covered with titanium, **thereby performing a generally etching action.** This etching action will be carried out for a time period of approximately 20 seconds. This ionized metal etching action, while cleaning the contact 6, will result in some depositing of metal atoms 9 on the surface of the contact 6, as illustrated in FIG. 1C. (Column 9 lines 47-65)

The difference between Licata et al. and the present claims is that initially having the substrate deposited with a layer of resistor material patterned to form a plurality of nichrome resistors is not discussed.

Licata discussed above teach that semiconductor wafers can have deposited thereon layers of metal interconnect film stacks. (See Licata discussed above)

Lane et al. teach forming thin film resistors on a semi-conductor integrated circuit wafer comprising the steps of depositing a resistor layer for forming the film resistors, depositing a protective layer to define the thin film resistors, etching to remove the protective layer in areas not protected by the photoresist, removing the photoresist, and then subjecting the wafer to radio-frequency sputter etch to remove portions of the resistor layer for defining the thin film resistors. Conductors are then formed on the wafer for connecting the thin film resistors together and to other components on the wafer. (See Abstract)

The motivation for selecting a wafer with resistors thereon is that it allows for production of a semi-conductor integrated circuit. (See Abstract)

Therefore, it would have been obvious to one of ordinary skill in the art at the time the invention was made to have modified Licata by utilizing a wafer with resistors thereon as taught by Lane because it allows for the production of a semi-conductor integrated circuit.

2. Claim 16 is rejected under 35 U.S.C. 103(a) as being unpatentable over Licata in view of Lane et al. as applied to claims 13 and 14 above, and further in view of Bauer (U.S. Pat. 4,647,361).



The difference not yet discussed is the control of temperature during sputter etching.

Bauer teach ***sputter etching of substrates before deposition by fixing the wafer temperature in the range of approximately 350-550 degrees Centigrade.***

The sputter etching can be carried out in either a double step process or single step process. The single step process utilizing the temperature of 350-550 degrees Centigrade. (Column 7 lines 29-31, lines 34-39, lines 60-68; Column 8 lines 13-18)

The motivation for sputter etching at a temperature between 350-550 degrees Centigrade is that it allows for removing oxides. (Column 7 lines 60-68; Column 8 lines 1-12)

Therefore, it would have been obvious to one of ordinary skill in the art at the time the invention was made to have maintained the temperature of the wafer between 350-550 degrees Centigrade as taught by Bauer because it allows for removing oxides.

3. Claims 17 and 18 are rejected under 35 U.S.C. 103(a) as being unpatentable over Licata in view of Lane et al. as applied to claims 13 and 14 above, and further in view of Lantsman (U.S. Pat. 5,589,041).

Licata discussed above teach applying a volts of 100 volts to the wafer and utilizing a RF frequency in the range of 0.2 to 80 MHz. (See Licata discussed above)

The difference not yet discussed is where the frequency applied to the inductive coil is 100 kHz is not discussed.

Lantsman teach ***sputter etching utilizing a RF power source of 0.1-27 MHz applied to the coil.*** (Column 4 lines 58-61)

The motivation for selecting a particular power to the coil is that it allows for controlling the temperature of the processing chamber. (Column 2 lines 27-31)

Therefore, it would have been obvious to one of ordinary skill in the art at the time the invention was made to have utilized an RF power to the coil of 0.1 MHz as taught by Lantsman because it allows for controlling the temperature of the processing chamber.

4. Claims 13 and 14 are rejected under 35 U.S.C. 103(a) as being unpatentable over Denning et al. (U.S. Pat. 6,451,181) in view of Licata (U.S. Pat. 6,132,564) and Lane et al. (GB 2 240 875).

Regarding claim 13, Denning et al. teach a multiple reactor system in Fig. 1 (Figure 1) The multiple reactor system has first preclean chambers 10. In addition, the preclean chamber cleans exposed conductive surfaces of the semiconductor wafer in preparation for subsequent deposition thereon. (Column 5 lines 21-29) The multi chamber also has a second reactor 40 or 70 for deposition of a layer. (Column 5 lines 32-33; Column 5 lines 44-45) The chambers are connected by a buffer chamber 3, transfer chamber 9 and transfer chamber 2. (Column 5 lines 29-32) Fig. 2 illustrates in greater detail the RF preclean chamber 10, illustrated in Fig. 1. Chamber 10 includes a dome 12. (Column 6 lines 1-2) A coil 16 cylindrical in shape surrounds the quartz dome 12. The coil 16 is supplied with low frequency RF power via a coil power supply 26. (Column 6 lines 17-19) As illustrated in Fig. 2, a semiconductor wafer 22 is placed on a wafer pedestal 20 where it is subsequently processed. The wafer pedestal 20 is provided with high frequency RF power via a pedestal power supply 24. (Column 6

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lines 20-24) A gas supply line 28 is connected to the chamber. The gases supplied to the internal chamber environment are generally inert sputtering gasses and typically include argon, nitrogen, or xenon. (Column 6 lines 27-31) Fig. 3 shows the chamber 40 for metal deposition. Chamber 40 can include a shield 42, a rotating magnetic assembly 46, a target 48 made of a metal powered by a direct current power source 50 and a coil 52. (Column 6 lines 40-65) Fig. 4 shows chamber 70 for metal deposition. In a manner similar to Fig. 3 the chamber 70 comprises a shield 72, a rotating magnet assembly 76, a copper target 78, a target power supply 80, coils 82, a coil power supply 84, a wafer pedestal 86, a pedestal power supply 88, an input gas source 92 and an exhaust port 94. (Column 8 lines 1-8) There are means in the multi chamber system for advancing the wafer in the form of robotics from the first to second chamber. (Column 5 lines 1-6)

Regarding claim 14, Denning et al. teach that the RF precleaning chamber includes means 28 for supplying argon to the chamber. (Column 6 lines 27-31) The argon etches the substrate. (Column 11 lines 11-13)

The difference between Denning et al. and the present claims is that maintaining unbroken vacuum conditions is not discussed (Claim 13) and treating nichrome resistors in the chambers is not discussed (Claim 13).

Regarding maintaining of the unbroken conditions between chambers of claim 13, Denning et al. discussed above already teach the maintaining controlled atmospheres in the buffer chamber and transfer chambers. (See Denning et al. discussed above) Licata et al. teach in FIG. 3 for example, diagrammatically illustrates a

***semiconductor wafer processing cluster tool 100*** for carrying out certain of the embodiments of the methods described above. The tool 100 preferably includes a ***vacuum transfer module 103 (Compare to Applicant's requirement for maintaining vacuum between the reactors)*** to which are attached one or two loadlock modules 101,102 which are connected to two positions of the transfer module 103 ***having a conventional robot transfer arm 104 (Compare to Applicant's requirement for a means for advancing the wafer)*** therein. The transfer module 103 is illustrated as having three additional positions to which are attached ***processing modules 105, 106 and 107***, none of which need be a dedicated precleaning module. While only three such additional positions are illustrated, ***more may be provided or to one may be connected a further transfer module for transfer of substrates to other processing modules attached thereto. (Column 10 lines 44-57)***

The motivation for maintaining a vacuum in the transfer and buffer chambers is that it allows for reducing contaminants during transport. (Denning et al. Column 5 lines 33-37)

Regarding the treating of nichrome resistors of claim 13, both Denning et al. and Licata et al. establish forming wafers that can have deposited thereon layers of metal interconnect film stacks. (See Denning et al. Column 1 lines 5-10; Licata et al. Column 1 lines 12-19) Lane et al. teach forming thin film resistors on a semi-conductor integrated circuit wafer comprising the steps of depositing a resistor layer for forming the film resistors, depositing a protective layer to define the thin film resistors, etching to remove the protective layer in areas not protected by the photoresist, removing the

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photoresist, and then subjecting the wafer to radio-frequency sputter etch to remove portions of the resistor layer for defining the thin film resistors. Conductors are then formed on the wafer for connecting the thin film resistors together and to other components on the wafer. (See Abstract)

The motivation for selecting a wafer with resistors thereon is that it allows for production of a semi-conductor integrated circuit. (See Abstract)

Therefore, it would have been obvious to one of ordinary skill in the art at the time the invention was made to have modified Denning et al. by maintaining vacuums in the buffer and transfer chambers as taught by Licata et al. and by utilizing a wafer with resistors thereon as taught by Lane because it allows for preventing contamination of the wafer and the production of a semi-conductor integrated circuit.

5. Claim 16 is rejected under 35 U.S.C. 103(a) as being unpatentable over Denning et al. in view of Licata and Lane et al. as applied to claims 13 and 14 above, and further in view of Bauer (U.S. Pat. 4,647,361).

The difference not yet discussed is the control of temperature during sputter etching.

Bauer teach **sputter etching of substrates before deposition by fixing the wafer temperature in the range of approximately 350-550 degrees Centigrade.**

The sputter etching can be carried out in either a double step process or single step process. The single step process utilizing the temperature of 350-550 degrees Centigrade. (Column 7 lines 29-31, lines 34-39, lines 60-68; Column 8 lines 13-18)

The motivation for sputter etching at a temperature between 350-550 degrees Centigrade is that it allows for removing oxides. (Column 7 lines 60-68; Column 8 lines 1-12)

Therefore, it would have been obvious to one of ordinary skill in the art at the time the invention was made to have maintained the temperature of the wafer between 350-550 degrees Centigrade as taught by Bauer because it allows for removing oxides.

6. Claims 17 and 18 are rejected under 35 U.S.C. 103(a) as being unpatentable over Denning et al. in view of Licata et al. and Lane et al. as applied to claims 13 and 14 above, and further in view of Lantsman (U.S. Pat. 5,589,041).

Licata discussed above teach applying a volts of 100 volts to the wafer and utilizing a RF frequency in the range of 0.2 to 80 MHz. (See Licata et al. Column 7 lines 28-33 ; Column 9 lines 39-46)

The difference not yet discussed is where the frequency applied to the inductive coil is 100 kHz is not discussed.

Lantsman teach ***sputter etching utilizing a RF power source of 0.1-27 MHz applied to the coil.*** (Column 4 lines 58-61)

The motivation for selecting a particular power to the coil is that it allows for controlling the temperature of the processing chamber. (Column 2 lines 27-31)

Therefore, it would have been obvious to one of ordinary skill in the art at the time the invention was made to have utilized an RF power to the coil of 0.1 MHz as taught by Lantsman because it allows for controlling the temperature of the processing chamber.

***Response to Arguments***

In response to the argument that the reference to Lantsman does not disclose means for applying only an RF signal to the wafer, it is argued that the claim as written still reads on the reference to Lantsman. Specifically the phrase "... (d) means for applying only an RF signal to the wafer...." is understood to mean that a RF power source (the means) is applying an RF signal to the wafer and that no other signal is applied to the wafer from the power source for instance a RF+DC signal. Furthermore, newly cited reference to Denning et al. suggests a sputter etch chamber in which an RF source is the means for applying a signal to the wafer. No sputter target is present in the chamber.

Any inquiry concerning this communication or earlier communications from the examiner should be directed to Rodney G. McDonald whose telephone number is 571-272-1340. The examiner can normally be reached on M- Th with Every other Friday off.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Nam X. Nguyen can be reached on 571-272-1342. The fax phone number for the organization where this application or proceeding is assigned is 703-872-9306.

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Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see <http://pair-direct.uspto.gov>. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free).



Rodney G. McDonald  
Primary Examiner  
Art Unit 1753

RM  
April 28, 2004